FORM PTO-1390 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE ATTORNEY'S DOCKET NUMBER (REV 11-2000) 2490-17 (If known, see 37 C.F.B. 1.5) TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) 020619 **CONCERNING A FILING UNDER 35 U.S.C. 371** INTERNATIONAL APPLICATION NO. INTERNATIONAL FILING DATE PRIORITY DATE CLAIMED PCT/GB00/03483 08/09/2000 08/09/1999 TITLE OF INVENTION SEMICONDUCTOR LASER DIODE WITH A DISTRIBUTED REFLECTOR APPLICANT(S) FOR DO/EO/US MASSARA, A. et al. Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information: This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371. 1.4 This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 2. П Ø 3. This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below. 4. \boxtimes The U.S. has been elected by the expiration of 19 months from the priority date (Article 31). 5. A copy of the International Application as filed (35 U.S.C. 371(c)(2)). a. is attached hereto (required only if not communicated by the International Bureau). \boxtimes b has been communicated by the International Bureau. C. is not required, as the application was filed in the United States Receiving Office (RO/US). П An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). a. is attached hereto. \Box h. has been previously submitted under 35 U.S.C. 154(d)(4). 7. \bowtie Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) a. are attached hereto (required only if not communicated by the International Bureau). \boxtimes b. have been communicated by the International Bureau. have not been made; however, the time limit for making such amendments has NOT expired. C. d. have not been made and will not be made. 8. An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). 10₽ A English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)). Items 11 To 20 below concern document(s) or information included: 11. An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98. 12. An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included. 13. A FIRST preliminary amendment. 14. A SECOND or SUBSEQUENT preliminary amendment. 15 A substitute specification. 16. A change of power of attorney and/or address letter. 17. A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825. A second copy of the published international application under 35 U.S.C. 154(d)(4). 18. A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4). 19. \bowtie 20. Other items or information. PTO Form 1449

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BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5): Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO											
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NIXON & VANDERHYE P.C.										ŀ	
1100 North Glebe Road, 8 th Floor											
Arlington, Virginia 22201-4714 Telephone: (703) 816-4000 Leonard C. Mitchard								ļ			
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In re Patent Application of

MASSARA, A. et al.

Atty. Ref.: 2490-17

Serial No. unknown

Group:

Filed: March 8, 2002

Examiner:

For: SEMICONDUCTOR LASER DIODE WITH A DISTRIBUTED REFLECTOR

* * * * * * * * * *

March 8, 2002

Assistant Commissioner for Patents Washington, DC 20231

Sir:

PRELIMINARY AMENDMENT

In order to place the above-identified application in better condition for examination, please amend the application as follows:

IN THE SPECIFICATION

Please substitute the following paragraphs in the specification for corresponding paragraphs previously presented. A copy of the amended specification paragraphs showing current revisions is attached.

Page 1, before the first line, please insert as a separate paragraph:

This application is the US national phase of international application PCT/GB00/03483 filed 08 September 2000, which designated the US.

MASSARA, A. et al. Serial No. <u>unknown</u> IN THE CLAIMS

Please substitute the following amended claims for corresponding claims previously presented. A copy of the amended claims showing current revisions is attached.

- 3. An optical device as claimed in claim 1, wherein the two-dimensional array is in a plane parallel to the active layer and extends to a depth comparable to that of the active layer.
- 4. An optical device as claimed in claim 1, wherein the individual elements are holes.
- 7. An optical device, as claimed in claim 4, wherein the holes extend to a depth comparable to that of the active layer in a direction that is perpendicular to the plane parallel to the active layer.
- 8. An optical device, as claimed in claim 4, wherein the holes extend to a depth comparable to that of the active layer in a direction that is not perpendicular to the plane parallel to the active layer.
- 9. An optical device, as claimed in claim 4, wherein the holes are regions of different refractive index to that of the device structure.
- 10. An optical device, as claimed in claim 4, wherein the holes are regions of different gain or loss to that of the device structure.

MASSARA, A. et al.

Serial No. unknown

- 11. An optical device, as claimed in claim 3, wherein the distributed reflector does not pierce the active region.
- 12. An optical device, as claimed in claim 3, wherein the distributed reflector partially pierces the active region.
- 13. An optical device, as claimed in claim 3, wherein the distributed reflector fully pierces the active region.
- 14. An optical device, as claimed in claim 1, wherein the distributed reflector is within the device.
- 17. An optical device as claimed in claim 1, with means for varying the electrical bias or biases applied to the device to obtain efficient optical emission in single wavelength operation.
- 19. An optical device, as claimed in claim 1, which is integrated with separate amplifying, absorbing or passive sections.
 - 21. An optical device, as claimed in claim 1, with means for being pulsed

MASSARA, A. et al. Serial No. unknown

REMARKS

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page(s) is captioned "Version With Markings To Show Changes Made."

Respectfully submitted,

NIXON & VANDERHYE P.C.

By:

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Page 1, before the first line, please insert as a separate paragraph:

This application is the US national phase of international application PCT/GB00/03483 filed 08 September 2000, which designated the US.

IN THE CLAIMS

- 3. An optical device as claimed in claim 1-or-2, wherein the two-dimensional array is in a plane parallel to the active layer and extends to a depth comparable to that of the active layer.
- 4. An optical device as claimed in claim 1, 2 or 3, wherein the individual elements are holes.
- 7. An optical device, as claimed in one of claims 4 to 6, wherein the holes extend to a depth comparable to that of the active layer in a direction that is perpendicular to the plane parallel to the active layer.
- 8. An optical device, as claimed in one of claims 4-to 6, wherein the holes extend to a depth comparable to that of the active layer in a direction that is not perpendicular to the plane parallel to the active layer.

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'Serial'No. unknown

- 9. An optical device, as claimed in one of claims 4-to-8, wherein the holes are regions of different refractive index to that of the device structure.
- 10. An optical device, as claimed in one of claims 4 to 9, wherein the holes are regions of different gain or loss to that of the device structure.
- 11. An optical device, as claimed in one of claims 3-to 10, wherein the distributed reflector does not pierce the active region.
- 12. An optical device, as claimed in one of claims 3-to 10, wherein the distributed reflector partially pierces the active region.
- 13. An optical device, as claimed in one of claims 3-to 10, wherein the distributed reflector fully pierces the active region.
- 14. An optical device, as claimed in any preceding claim 1, wherein the distributed reflector is within the device.
- 17. An optical device as claimed in any preceding claim 1, with means for varying the electrical bias or biases applied to the device to obtain efficient optical emission in single wavelength operation.

MASSARA, A. et al. Serial No. unknown

- 19. An optical device, as claimed in any preceding claim 1, which is integrated with separate amplifying, absorbing or passive sections.
- 21. An optical device, as claimed in a in any preceding claim 1, with means for being pulsed by gain switching, Q-switching or mode-locking techniques.

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SEMICONDUCTOR LASER DIODE WITH A DISTRIBUTED REFLECTOR

Laser devices are commonly used as light sources, and it is of particular interest to be able to obtain laser sources which have high quality spectral performance for data communication applications. It is of particular interest to be able to manufacture such devices in a relatively simple and low cost way, to achieve a robust device. In particular it is advantageous to achieve a device with a highly selective optical spectrum, that is, a device which produces a large amplitude peak at one specific wavelength of output light.

One type of laser device which can be used as such a source is a Distributed Feedback (DFB) laser, and the related Distributed Bragg Reflector (DBR) laser. However, conventional techniques for manufacturing such devices include regrowth steps, which make the manufacturing relatively expensive.

The paper "1.5 μ m wavelength DBR lasers consisting of $3\lambda/4$ -semiconductor and $3\lambda/4$ -groove buried with benzocyclobutene", M.M.Raj, J. Wiedmann, Y. Saka, H. Yasumoto and S. Arai. *Electronics Letter*, Vol.. 35, No. 16, pp. 1335-1337 describes a method of manufacturing deep etched (DBR) lasers. Since this technique involves etching into and across the active layer, the wave ceases to be guided within the etch, which means that these devices are likely to be inherently lossy.

The present invention relates to a laser device, with a ridge waveguide, with a distributed reflector on either side of the central ridge.

Since the light wave remains guided, this has the advantage that the device is relatively efficient.

Preferably, the reflector can be obtained by etching into the active layer on either side of the waveguide.

This has the advantage that the reflector can be obtained without using additional regrowth steps.

Preferably, the reflector takes the form of a twodimensional pattern. This allows efficient reflection, while allowing the reflector to be contained in a relatively short length of the device.

For a better understanding of the present invention, and to show how it may be put into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a plan view of a laser device in accordance with the invention.

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Figure 2 is an enlarged schematic illustration of a region of Figure 1.

Figure 3 is a cross-sectional view through the device of Figure 1.

Figure 4 illustrates the room temperature (20°C) CW optical spectra at 60mA for (a) pre-etch non-AR coated and (b) post-etch AR coated conditions of the device of Figure 1.

Figure 5 illustrates the post-etch room temperature (20°C) CW L-I characteristics of the device of Figure 1.

Figure 6 illustrates the post-etch, room temperature (20°C) variation of lasing wavelength with CW bias current for the device of Figure 1.

Figure 1 is a top plan view of a laser device in accordance with the invention. The device 2 is an InGaAsP-InP laser, with a ridge-waveguide 4. The device consists of seven 0.8% compressively strained quantum wells, and operates at a centre wavelength of ~1.29 μ m. The laser is 350 μ m long, and acts as a Fabry-Perot (F-P) laser. It is cleaved on both end facets 6,8. The laser is bonded junction side up on a temperature-controlled submount (not shown) and the output can be connected via a lensed fibre. The back

-3-

facet 6 is AR coated to 0.1%, in order to suppress the F-P modes.

Figure 3 is a cross-sectional view, taken on line A-A in Figure 1. As shown in Figure 3, the device has an active region 10 within the structure, with a silicon dioxide layer 12, having a metal layer 14 above it as the uppermost layers. The central ridge-waveguide has a width W of, for example, approximately $3\mu\text{m}$, with etched channels of width X of approximately $8\mu\text{m}$ on either side of the ridge waveguide.

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In accordance with the preferred embodiment of the invention, a distributed reflector structure is provided on either side of the central ridge waveguide, leaving the waveguide itself untouched.

In this illustrated embodiment of the invention, the distributed reflectors take the form of an etched 2D-lattice grating 18. The grating 18 is etched into the bottom surfaces 20 of the channels 16, over a section of the cavity. This section has a length L of approximately $50\,\mu\text{m}$, and is located towards the back facet 6 of the device, for example approximately $50\,\mu\text{m}$ from the back facet.

Figure 2 is an enlarged view of the etched grating pattern in one of the channels 16. The array comprises a series of holes 22, etched through the top contact 14 to a depth which is comparable to the depth of the active region 10. In this illustrated embodiment, the holes 22 are arranged in a hexagonal array. That is, each hole away from the edge of the array is surrounded by six equally spaced holes. This separation a is of the order of $0.60-0.65\mu m$, and the holes have a radius r such that the radius-to-pitch ratio r:a is 0.17, although it may be in the range of 0.17-0.33.

The grating pattern could also be a square array, or any pattern which provides a suitable reflector.

Preferably, the holes are etched to a depth which

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is very close to, or, more preferably, into the active region.

Advantageously, the holes can be obtained by post-processing using any available etching technique, for example, focused ion bean etching (FIBE) or reactive ion etching (RIE), without requiring any subsequent regrowth. This has the advantage that the device can be manufactured relatively simply and inexpensively.

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This structure has the further advantage that the holes, which act as the reflectors, provide a high refractive index contrast ratio between the holes and the material of the device, of approximately 1:3.5.

In order to improve passivation, it is possible to fill in the etched holes with a suitable material, such as benzocyclobutene (BCB), which reduces this ratio to approximately 1.5:3.5. However, this ratio is sufficiently large that a highly selective characteristic can be obtained, over a short etched length.

The post-etch performance of the device is characterised in terms of the optical spectra.

Measurements are taken at room temperature (20°C) under CW bias conditions. Figure 4a shows the pre-etch spectrum before AR coating at 60mA. This is indicative of a typical multi longitudinal mode F-P structure.

Figure 4b illustrates clearly that, after etching, the device lases in a single longitudinal mode. Purely single mode operation is maintained over the entire operating current range up to over 3 times threshold.

A typical SMSR value of >30dB is measured.

In order to investigate the stability of the lasting wavelength, the light current characteristics under CW bias conditions are measured at room temperature. Figure 5 shows a linear response above threshold, with no kinks evident, indicating that modehopping does not occur. A slope efficiency of 0.09 W/A

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is measured along with an output power of greater than 2.5mW at twice threshold current. At room temperature, a reduction in threshold current of 2mA was observed as a result of the etch.

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Single mode operation is further evidenced in Figure 6, which shows the variation of peak wavelength with CW bias current at room temperature (20°C). From threshold up to 85mA, the lasing wavelength is found to vary linearly at 0.009nm/mA, indicating mode-hop-free operation. The device spectra remain single mode over this range. Single mode emission is found to vary at the rate of 0.08nm/°C around room temperature.

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One possible use of the device of the invention is in an integrated device which has, say, four such laser sources on a single device, with the distributed reflector structures of the four sources being different, such that the integrated device can selectively provide a source at any of four wavelengths.

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There is thus described a technique which allows manufacture of a single-contact, mode-hop-free single longitudinal mode laser operating CW at room temperature, and bit rates up to approximately 10 GHz, to be produced from a previously multi-mode Fabry-Perot ridge-waveguide device.

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CLAIMS:

- 1. An optical device, comprising a laser diode having a ridge waveguide located above an active layer, and having a distributed reflector in the form of a lattice of individual elements, wherein the elements are arranged in a two-dimensional array on either side of the ridge waveguide.
- An optical device as claimed in claim 1,
 wherein the distributed reflector comprises a structure in material above the active layer on either side of the ridge waveguide.
 - 3. An optical device as claimed in claim 1 or 2, wherein the two-dimensional array is in a plane parallel to the active layer and extends to a depth comparable to that of the active layer.
 - An optical device as claimed in claim 1, 2 or
 wherein the individual elements are holes.
 - 5. An optical device as claimed in claim 4, wherein the holes are arranged in a hexagonal array.
 - 6. An optical device as claimed in claim 4, wherein the holes are arranged in a square array.
 - 7. An optical device, as claimed in one of claims 4 to 6, wherein the holes extend to a depth comparable to that of the active layer in a direction that is perpendicular to the plane parallel to the active layer.
 - 8. An optical device, as claimed in one of claims 4 to 6, wherein the holes extend to a depth comparable to that of the active layer in a direction that is not perpendicular to the plane parallel to the active layer.
- 9. An optical device, as claimed in one of claims 4 to 8, wherein the holes are regions of different refractive index to that of the device structure.
 - 10. An optical device, as claimed in one of

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claims 4 to 9, wherein the holes are regions of different gain or loss to that of the device structure.

- An optical device, as claimed in one of claims 3 to 10, wherein the distributed reflector does not pierce the active region.
- An optical device, as claimed in one of claims 3 to 10, wherein the distributed reflector partially pierces the active region.
- 13. An optical device, as claimed in one of claims 3 to 10, wherein the distributed reflector fully pierces the active region.
 - 14. An optical device, as claimed in any preceding claim , wherein the distributed reflector is within the device.
- 15. An optical device, as claimed in claim 14, 15 wherein the distributed reflector is within a pumped region.
 - An optical device as claimed in claim 14, wherein the distributed reflector is within an unpumped region.
 - An optical device as claimed in any preceding 17. claim, with means for varying the electrical bias or biases applied to the device to obtain efficient optical emission in single wavelength operation.
- 18. An optical device, as claimed in claim 17, 25 wherein the emission wavelength may be controlled/tuned.
 - An optical device, as claimed in any preceding claim, which is integrated with separate amplifying, absorbing or passive sections.
 - An optical device, as claimed in claim 19, where the amplifying or absorbing sections have gain/loss modulation.
- An optical device, as claimed in any 35 preceding claim, with means for being pulsed by gain switching, Q-switching or mode-locking techniques.

AMENDED SHEET

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization International Bureau



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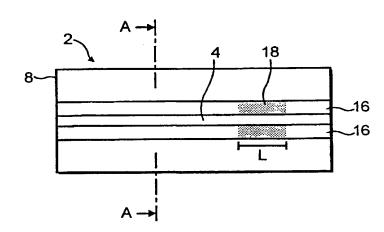
- (74) Agent: O'CONNELL, David, Christopher; Haseltine Lake & Co., Imperial House, 15-19 Kingsway, London WC2B 6UD (GB).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
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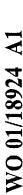
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

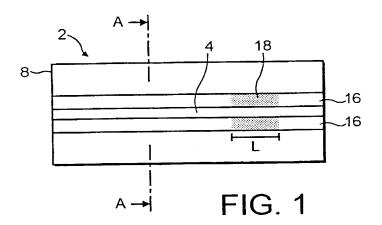
(54) Title: SEMICONDUCTOR LASER DIODE WITH A DISTRIBUTED REFLECTOR

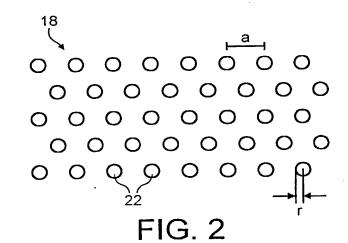


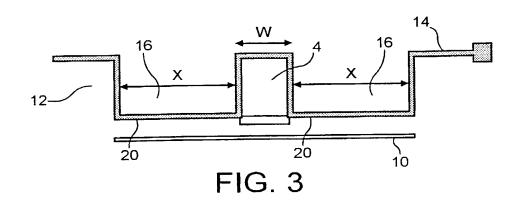
(57) Abstract: There is disclosed a laser diode with a ridge waveguide (14), in which a distributed reflector takes the form of an array of holes (22) etched into the surface of the device on either side of the central waveguide.



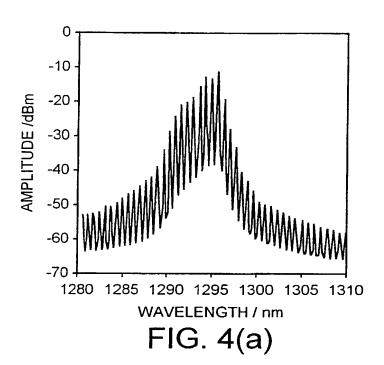
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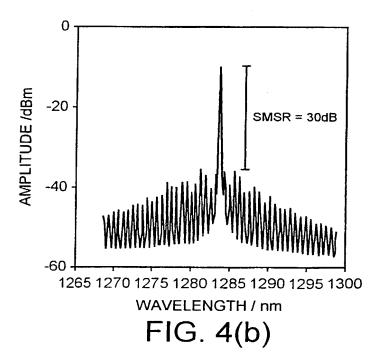






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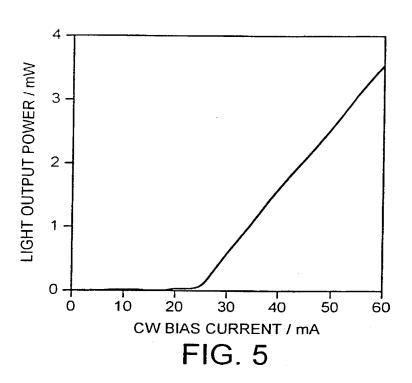
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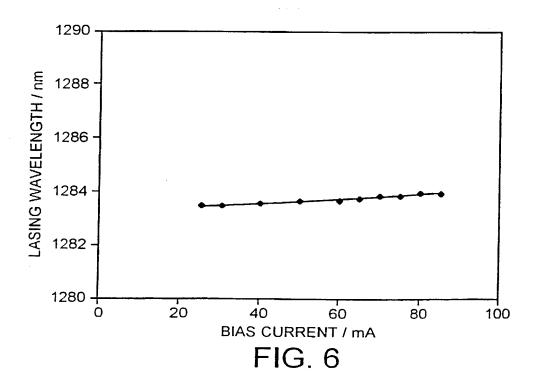
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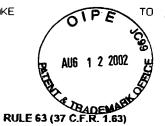
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2490-17 HL76966/002/DCO/JJM

Nixon & Vanderhye P.C. (10/99) (Domestic Non-Assigned/Foreign) Page 1

INVENTORS DECLARATION FOR PATENT APPLICATION IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, mailing address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the inventor entitled:

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the specification of v		applicable box(s)):				
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was filed on		March 8, 2002	as U.S. Application Seri	al No10/07	0,619	(Atty Dkt. No. 2490-17)
		nal application No.	PCT/GB00/03483	on	08/09/2000	
and (if applicable to	U.S. of PCT a	application) was amend	ed on		6-11	
amendment referred defined in 37 C.F.R. listed below and hav	d to above. I a . 1.56. I hereb ve also idenlifi med or, if no p	icknowledge the duly to ly claim foreign priority t ed below any foreign an	ontents of the above identified sp disclose to the Patent Office all benefits under 35 U.S.C. 119/36 uplication for patent or inventor's the filing date of this application	information kn 5 of any foreign certificate hav	own to me to b	e material to patentability as
	cation Numbe	r	Country			Day/Month/Year Filed
9	9921445.4		Great Britain			8 September 1999
		5 U.S.C. 120/365 of all p	orior United States and PCT inte	mational applic	cations listed a	bove or below:
Prior U.S./PCT App	dication(s):					Status: patented
Application Serial I			Day/Month/Year Filed			pending, abandoned
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 $oxed{ imes}$ See attached sheet(s) for additional inventor(s) information!!



2490-17 Serial No. 10/070,819 Nixon & Vanderhye P.C. (10/99 (Domestic Non-Assigned/Foreign) Page 2

. 3 .	Inventor's Signature:			Date:	
	Inventor:	Richard (first)	V.	Penty	British
	Residence: (city)	Bristol		√ (last) (state/country) Great Britain	(citizenship)
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	(Zip Code)	BS6 6AG			
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		(first)	MI	(last)	(citizenship)
	Residence: (city)	Bath		(state/country) Great Britain	(Gill Cristing)
	Mailing Address:	57 Coombe Park, Westo	n, Bath, Great Britain	**	T-148
	(Zip Code)	BA1 3NH			

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Nixon & Vanderhye P.C. (10/99) (Domestic Non-Assigned/Foreign) Page 1

RULE 63 (37 C.F.R. T.63) INVENTORS DECLARATION FOR PATENT APPLICATION IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, mailing address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is tisted below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

matter	which is claimed and for	which a patent is sought on SEMICONDUCTOR LA	the invention entitled: SER DIODE WITH A DISTRIBU	CED REEL ECTOR	are noted bolow, or the subject
the spe	cification of which (chec	k applicable box(s)):	221.21002.1111.77.07011(100	LD KEI LECTOR	
□ i	s attached hereto				
=	was filed on	March 8, 2002	as U.S. Application Senal N	o. 10/070,619	(Atty Dkt. No. 2490-17)
Øv	was filed as PCT Interna	tional application No.	PCT/GB00/03483	on 08/09/200	
and (if i	applicable to U.S. or PC	application) was amended	on		
defined listed be which p	in 37 C.F.R. 1.56. I hen elow and have also idenl	i acknowledge the duty to dis aby claim foreign priority ben lified below any foreign appli	ents of the above identified specificlose to the Patent Office all info efits under 35 U.S.C. 119/365 of cation for patent or inventor's cerie e filing date of this application;	mation known to me to	nims, as amended by any be material to patentability as s) for patent or inventor's certifica te before that of the application or
•	Application Num	ber	Country		Day/Month/Year Filed
	9921445.4		Great Britain		8 September 1999
	Application Numi	bor	ited States provisional application Date/Month/Year Filed		
nereby	ciaim the benefit under	35 U.S.C. 120/365 of all prio	r United States and PCT internati	onal applications listed	above or below:
Prior U.	S./PCT Application(s):				Status: patented
Applica	tion Serial No.		Day/Month/Year Filed		pending, abandoned
	PCT/GB00/0348	3	08/09/2000		,
application attorney in the Pa Hosmer, Stanley (Jr. 29366 34776; U 35329; J delete an	on of any patent issues s thereof (of the same ac tient and Trademark Off 30184; Robert W. Faris, C. Spooner. 27393; Leor Simary J. Wilson, 32955 Ipdeep S. Gill, 37334; M oseph A. Rhoa, 37515; I ny ettorney names/numb	mereon. And on behalf of the 4714, telephone number (74 fdress) individually and collected connected therewith and 1,31352; Richard G. Besha, 2 hard C. Mitchard, 29009; Dua; J. Scott Davidson, 33489; Aichael J. Shea, 34725; Donal Raymond Y. Mah, 41426; Chers no longer with the firm arts no longer with the longer longer with the longer longer with the longer longer with the longer longer longer with the longer	e owner(s) hereof, I hereby appoin 30) 818-4000 (to whom all commit ctively owner's/owners' attorneys with the resulting patent: Larry S 12770; Mark E. Nusbaum, 32348; Ine M. Byers, 33363; Jeffry H. Ne Alan M. Kagen, 36178; Robert A. Id L. Jackson, 41090; Michelle N. Ing Comunity 3, 31097; Geny T. To	int NIXON & VANDERH munications are to be to prosecute this application. Nixon. 25640: Arthur R Michael J. Keenan, 3218on, 30481; John R. Le Molan, 29834; B. J. Sac Lester, 32331; Frank P inigawa, 43180. I also sections directly communications directly communications.	ation and to transact all business t. Crawford, 25327; James T. 106; Bryan H. Davidson, 30251; istova, 33149; H. Warren Burnam forff, 36663; James D. Berquist,
l .	Inventor's Signature:	•	and a second of the second of the	Date:	
	Inventor:	Aeneas	8.	Massara Date:	British
		(first)	Mi	(last)	(citizenship)
	Residence: (city)	Essex	(state/cor	untry) Great Britain	(chechanp)
	Mailing Address:	8 Garthwood Close, West	Bergholl, Colchester, Essex, Gre	at Britain	
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	Inventor's Cianata	\//	_		
\cap	Inventor's Signature: Inventor:	X 4 300	<u>~</u>		30/04/2002
W.	HITERROI.	/ baurence	<u>J.</u>	Sargent	British
)U	Residence: (city)	.Marlow, Buckinghamshire	GRY (atata/a-)	(last)	(chizenship)
1	Mailing Address:		arlow, Buckinghamshire, Great B		
ν	(Zip Code)	SL7 3BU	now, odckingnamsnire, Great 8	wan	
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 $oxed{ imes}$ See attached sheet(s) for additional inventor(s) information!!



2490-17 Serial No. 10/070,619 Nixon & Vanderhye P.C. (10/99 (Domestic Non-Assigned/Foreign) Page 2

3.	Inventor's Signature:				Date:	
	Inventor:	Richard		Pen	ity	8ntish
		(first)	Mi	` (ias	t)	(citizenship)
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	(Zip Code)	BS6 6AG				
4.	Inventor's Signature:	-			Date:	-
	Inventor:	lan	Н.	Whi	te	British
		(first)	MI	(las	D	(citizenship)
	Residence: (city)	Bath		•	Great Britain	(,
	Mailing Address:	57 Coombe Park, Weston	n, Bath, Great Britain	- ' -		-
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Nixon & Vanderhye P.C. (10/99) (Domestic Non-Assigned/Foreign) Page 1

2490-17 HL76966/002/DCO/JJM

RULE 63 (37 C.F.R. 1.63) INVENTORS DECLARATION FOR PATENT APPLICATION IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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		SEMICONDUCTOR L	ASER DIODE WITH A DISTRIBU	TED REFLECTOR	
the sp	edification of which (chec	k applicable box(s)):		-	
	is attached hereto				
	was filed on	March 8, 2002	as U.S. Application Senat N	o. <u>10/070,619</u>	(Alty Dkt. No. 2490-17)
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and (if	applicable to U.S. or PC1	application) was amended	d on		
amend defined listed b which p	Iment referred to above. I d in 37 C.F.R. 1.56. I here below and have also ident priority is claimed or, if no	l acknowledge the duly to o aby claim foreign priority be ified below any foreign app	ntents of the above identified specifics. It is close to the Patent Office all inferences under 35 U.S.C. 119/365 of olication for patent or inventor's certhe filing date of this application:	mation known to me to be any foreign application(s) (material to patentability as
Priority	Foreign Application(s):				
	Application Numi	ber	Country		Day/Month/Year Filed
	9921445.4		Great Britain		8 September 1999
l hereb	y claim the benefit under Application Numl	35 U.S.C. §119(e) of any L ber	Inited States provisional applicatio Date/Month/Year Filed	n(s) listed below.	
hereb	y claim the benefit under	35 U.S.C. 120/365 of all pr	ior United States and PCT internat	lonal applications listed ab	ove or below:
Prior U	S./PCT Application(s):				Status: patented
Applic	ation Serial No.		Day/Month/Year Filed		pending, abandoned
	PCT/GB00/0348	3	08/09/2000		
attomey n the P dosmei Stanley Jr. 2936 34776; 35329; delete a	or, Affington, VA 22201- ys thereof (of the same of ratent and Trademark Offi r, 30184; Robert W. Faris C. Spooner, 27393; Leor 36; Mary J. Wilson, 32955 Updeep S. Gill, 37334; M Joseph A. Rhoa, 37515; I Iny attorney names/numb	4714, telephone number (Idress) individually and colloce connected therewith an , 31352; Richard G. Beshahard C. Mitchard, 29009; Di ; J. Scott Davidson, 33489 ichael J. Shea, 3472S; Dor Raymond Y. Mah, 41426; Cers no longer with the firm	the owner(s) hereof, I hereby apporton 3816-4000 (to whom all commers all commers and the commers at the commers at the commers of the commers at the commer	munications are to be din to prosecute this application, Nixon, 25640; Arthur R. C. Michael J. Keenan, 32106 elson, 30481; John R. Last Molan, 29834; B. J. Sadof. Lester, 32331; Frank P. Panigawa, 43180. I also autotions directly communicate cowner(s).	pected), and the following on and to transact all business crawford, 25327; James T. c; Bryan H. Davidson, 30251; ova, 33149; H. Warren Bumam f, 36663; James D. Berquist, resta, 19828; Joseph S. Presta horize Nivon & Vanderbye to
•	Inventor's Signature:	Aeneas	В.	Date: _	
	mredian.	(first)	в. Mi	Massara (last)	British (citizocabia)
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	Inventor's Signature:			0-4-	
	Inventor:	Laurence	J.	Date:	British
	377701 .	(first)	J. Mi	Sargent (last)	(citizenship)
	Residence: (city)	Marlow, Buckinghamshi			(Ciuzerianip)
	Mailing Address:		Marlow, Buckinghamshire, Great 8	ritain	
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 $oxed{ imes}$ See attached sheet(s) for additional inventor(s) information!!

2490-17 Serial No. 10/070,619 Nixon & Vanderhye P.C. (10/99 (Domestic Non-Assigned/Foreign)

		// //)	1.			Page 2
3.	_Inventor's Signature:	X Whi	1		Date: _	3/7/02
. (Inventor:	Richard	<u>'</u>	Penty		/ 'British
n) -	(first)	MICRY	(iast)		(citizenship)
//	Residence: (city)	Bristol CAMBRIDGE		(state/country) Great	Britain	
	Mailing Address:	55 Redland Road, Bristol, Grea	HOM missing	FARM HOUSE	MEETI	NG LANE,
	(Zip Code)	BOO BAO LITLINGTO	N LANE	ROYSTON SC	8 DO.	FLA
4.	Inventor's Signature:				Date:	
	Inventor:	lan	H.	White		British
		(first)	MI	(tasi)		(citkzenship)
	Residence: (city)	Bath		(state/country) Great I	Britain	
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	(Zip Code)	BA1 3NH				

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Nixon & Vanderhye P.C. (10/99) (Domestic Non-Assigned/Foreign) Page 1

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	pecification of which (che is attached hereto was filed on	March 8, 2002	as U.S. Application Serial No.	10/070,619	(Atty Dkt. No. 2490-17)
Ø	was filed as PCT Interna		PCT/GB00/03483	on 08/09/2000	
I here amend define listed I which	by state that I have review dment referred to above. d in 37 C.F.R. 1.56. I he below and have also ider priority is claimed or, if n	I acknowledge the duty to di reby claim foreign priority ber stifled below any foreign appli	ents of the above identified specifica sclose to the Patent Office all inform refits under 35 U.S.C. 119/365 of an cation for patent or inventor's certific re filing date of this application:	ation known to me to b v foreign application(s)	e material to patentability as for patent or inventor's certific
Priority	y Foreign Application(s): Application Num 9921445.4	ber	Country Great Britain		Day/Month/Year Filed 8 September 1999
l heret	oy claim the benefit under Application Num	35 U.S.C. §119(e) of any Ur ber	nited States provisional application(s) Date/Month/Year Filed	listed below.	÷
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Prior L Applic	J.S./PCT Application(s): ation Serial No. PCT/GB00/0348		Day/Month/Year Filed 08/09/2000		Status: patented pending, abandoned
impriso applica 8 th Floc attorne; in the P Hosmer Stanley Jr. 2936 34776; 35329; delete a attorney	nment, or both, under Setton or any patent issued for, Arlington, VA 22201-bys thereof (of the same a ratent and Trademark Offr, 30184; Robert W. Faris C. Spooner, 27393; Leo 36; Mary J. Wilson, 32956 Updeep S. Gill, 37334; M Joseph A. Rhoa, 37515; any attorney names/numb of firm, or other organizati	ction 1001 of Title 18 of the Lethereon. And on behalf of the 4714, telephone number (7) ddress) individually and collectice connected therewith and collection of the telephone number (7) and C. Mitchard, 29009; Duast, J. Scott Davidson, 33489; Alichael J. Shea, 34725; Donal Raymond Y. Mah, 41426; Chers no longer with the firm ar	e knowledge that willful false statemed brited States Code and that such will e owner(s) hereof, I hereby appoint I D3) 816-4000 (to whom all communictively owner's/owners' attorneys to pwith the resulting patent: Larry S. Ni 12770; Mark E. Nusbaum, 32348; Miune M. Byers, 33363; Jeffry H. Nelso Nan M. Kagen, 36178; Robert A. Modd L. Jackson, 41090; Michelle N. Leris Comuntzis, 31097; Gary T. Tanig and to act and rely solely on instruction on & Vanderhye on behalf of the owners.	Iful false statements m NIXON & VANDERHYI Ilications are to be dir prosecute this application, 25640; Arthur R. (chael J. Keenan, 32100, n. 30481; John R. Lastian, 29834; B. J. Sadoi ster, 32331; Frank P. Fawa, 43180. I also auins directly communication.	ay jeopardize the validity of the P.C., 1100 North Glebe Rd rected), and the following on and to transact all business Crawford, 25327; James T. 6; Bryan H. Davidson, 30251; ova, 33149; H. Warren Burnait, 36663; James D. Berquist, Presta, 19828; Joseph S. Presthorize Nixon & Vanderhye to
١.	Inventor's Signature: Inventor:	Aeneas	B. N	Date:	British
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•	Inventor's Signature:	Laurence	J. §	Date:	British
	Residence: (city)	(first) Marlow, Buckinghamshire	MI (state/country	(last)) Great Britain	(citizenship)
	Mailing Address: (Zip Code)	SL7 3BU	arlow, Buckinghamshire, Great Britali	<u> </u>	

oxtimes See attached sheet(s) for additional inventor(s) information!!

2490-17 Serial No. 10/070,619 Nixon & Vanderhye P.C. (10/99 (Domestic Non-Assigned/Foreign) Page 2

a 8	্ ি Inventor's Signature:				Data	
. 3.	Inventor:	Richard (first)	V. MI	Penty (last)	Date:	British (citizenship)
	Residence: (city)	Bristol			at Britain	
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	(Zip Code)	BS6 6AG				
4.	Inventor's Signature: Inventor:	lan	1 White	White	Date:	7 8 Z British
		(first)	MI	(last)		(citizenship)
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